July 1956

ENVIRONMENTAL QUARTERLY

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The Nuclear Jungle . . . a new field for the environmental engineer

Role of an Environmental Department

A report on the Second Annual Science Meeting of the EEI

Official publication of the
ENVIRONMENTAL EQUIPMENT INSTITUTE and the
INSTITUTE OF ENVIRONMENTAL ENGINEERS

Vol. 2, No. 3

THIRD QUARTER 1956

Letters to the Editor

Sir:

During the discussion period of the first session of the Chicago meeting, the statement was made by Mr. Vandal of North American Aviation that Wright Air Development Center was no longer supplying cultures for fungus testing. Upon return, Mr. Grimm checked this statement and found that the Materials Laboratory, Directorate of Research has supplied and is continuing to supply cultures to Air Force contractors testing to MIL-E-5272.

The statement was apparently the result of a misunderstanding; however, it did cause some confusion. In order to eliminate any possible doubt, it would be appreciated if you could include a statement in the Quarterly or in any notice you might be distributing that the Air Force policy in this matter has not changed.

The meeting this year [Second Annual Science Meeting of the EEI] was very good and very well managed. The Environmental Equipment Institute and members of the committee are to be congratulated.

JOHN R. GRIMM
Asst. Chief, Environmental Criteria Branch
Wright Air Development Center

Sir:

On Friday, June 8, 1956, I attended the meeting of the New York Metropolitan Chapter of the Science Section of the Environmental Equipment Institute.

Many things impressed me a great deal. There were over 50 engineers in attendance, and this in itself is an accomplishment for an organization so young. The effective organizing done by Mr. Roger Amorosi and the members of the New York Metropolitan Steering Committee is a feat of considerable significance. The panel discussion moderated by Mr. Friedman of Tenney was of extreme interest to all present. If this is an indication of things to come, the New York Metropolitan Chapter should go far in the newly forming Institute of Environmental Engineers.

H. F. SANDER (Vapor Heating Corporation)
Provisional President
Institute of Environmental Engineers

Sir:

Perhaps the original favorable impression I received at my first Environmental Institute convention was the interesting cross-section of representation at the meeting. While I expected to meet several people from environmental equipment companies and many representatives from aircraft and electronic system manufacturers, I was very pleased to encounter so many component manufacturers and Government people from many different agencies, ranging from missiles to bacteriological warfare. Certainly contact with men from so many branches of the environmental field will afford a profitable association for all members of the Institute. This will serve to enhance the Institute and permit it to grow in stature and representation.

I was particularly impressed by the opportunity to see what the Armed Services expect in regard to future environmental conditions, such as vibration and high temperature requirements.

Certainly one of the greatest advantages of such a meeting is the solving of respective problems. Difficult problems are often solved in minutes through association with men who already have handled similar situations. Not the least of the benefits derived was a more comprehensive understanding of the problems that environmental equipment manufacturers face in attempting to duplicate the difficult conditions required.

If I may offer recommendations for next year's meeting, I would certainly like to see more sessions on a reliability program similar to that conducted by Mr. Lusser of Redstone. Also I would like to see some positive attempt by the Institute to work with the Armed Services in reducing the number of different humidity specifications.

Personally, I believe the convention was a success and I would like to congratulate all those who had a part in its organization.

JAMES KERN
Foreman
Production Environmental Test Section
Westinghouse Air Arm Division

AIA Endorses EEI

EDITOR'S NOTE: The following is an excerpt from a project report by G. R. Stoltenberger, of the Accessory and Equipment Technical Committee, Aircraft Industries Association.

"The scope of this project was to attend the next Environmental Equipment Institute meeting . . . in Chicago, 19, 20 April 1956, and submit recommendations to AIA concerning our evaluation of the program of this group. . . .

"We have found the information presented in the last Environmental Equipment Institute Science Section meeting of extreme interest to our Evaluation Department personnel . . . concerning testing fixtures and techniques for new established Environmental Tests.

"We have developed a greater appreciation for the environmental problems which other people are encountering, especially from the standpoint of temperature shock. . . .

"We believe the type of information presented in the Science Section meeting would be of interest to the personnel in the various member companies of AIA that are conducting environmental tests. Also, it provides an opportunity to learn who has available equipment in which the environmental tests may be conducted. . . ."

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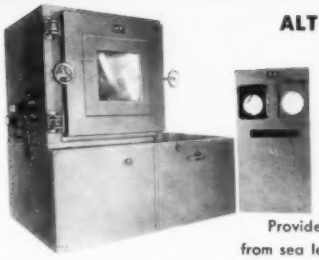

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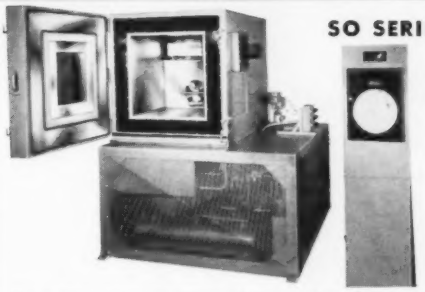

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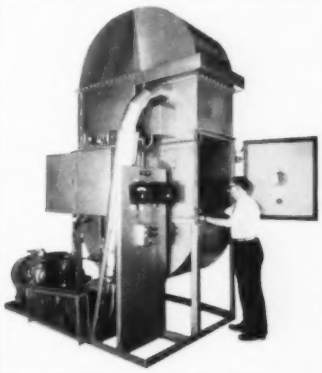

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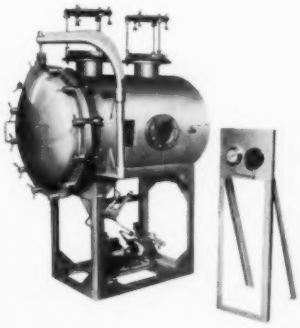

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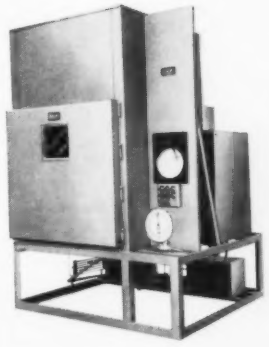

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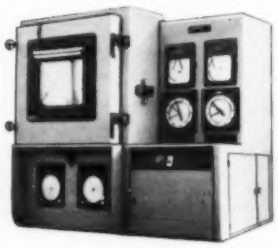

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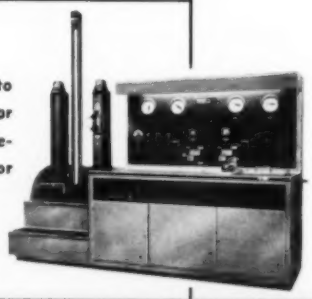

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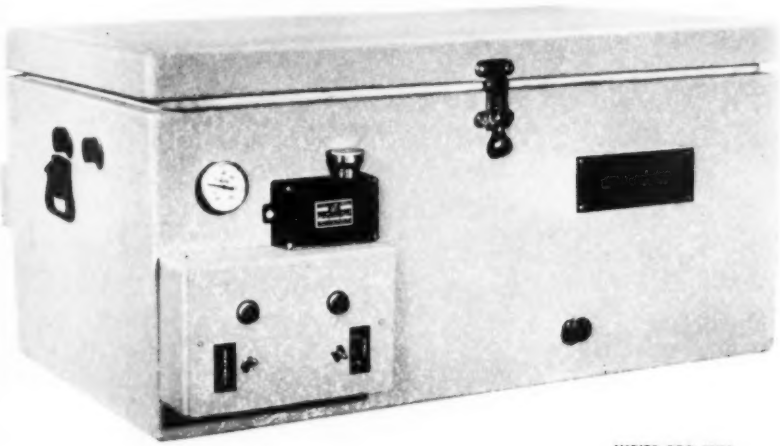

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Vol. 2, No. 3 Third Quarter — July 1956

ENVIRONMENTAL QUARTERLY

Official Publication of the Environmental Equipment Institute and the Institute of Environmental Engineers

Ray H. Mattingley, Editor

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The *Environmental Quarterly* solicits articles of general and technical interest in the environmental field. It does not pay for material selected for publication. Very short items are needed as well as full-length articles. Illustrations must be either black and white line drawings or glossy photographs. All manuscripts must be double-spaced. The author should include a brief biography, a statement of his present business connection, and a reproducible photograph of himself, where possible. Query the editor before submission. The editor will provide preparational guidance to any author on request. Please do not submit cartoons.

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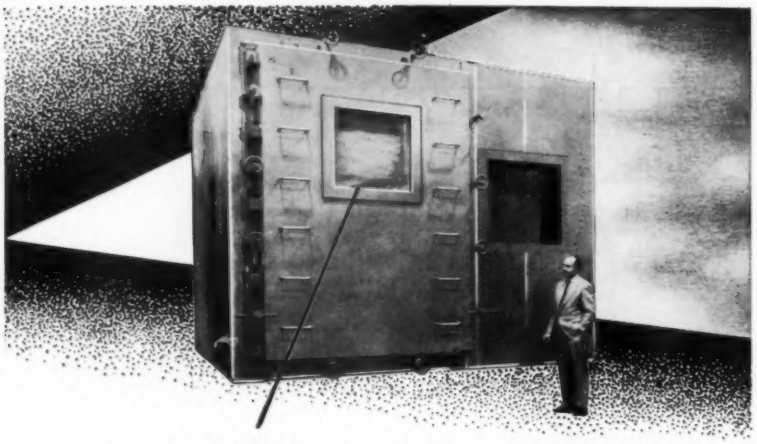

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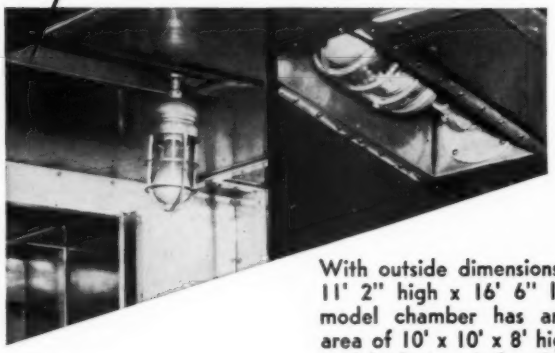

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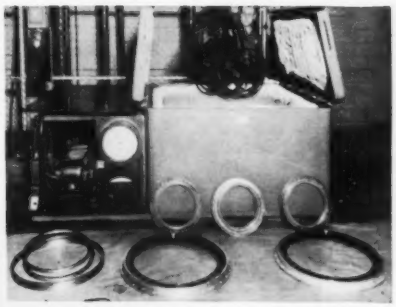

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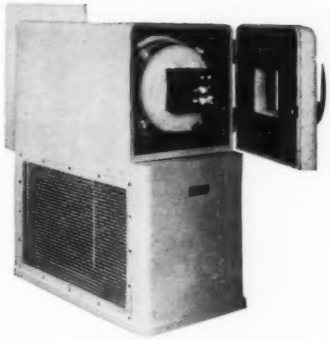

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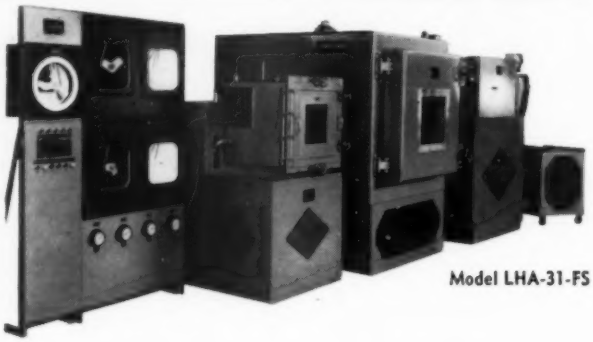

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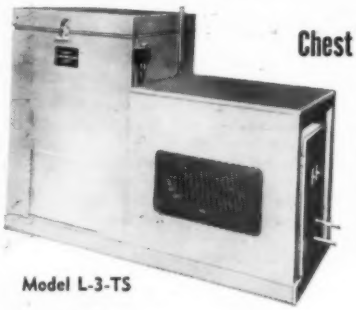

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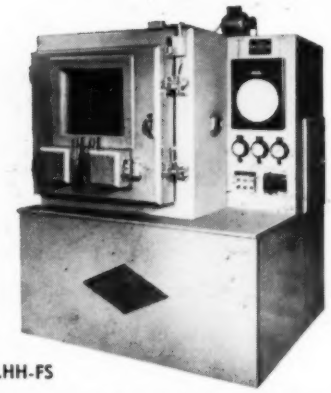

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The Nuclear Jungle

By ALAN E. SUROSKY, Nuclear Development Corporation of America

A new environment exists today to challenge the engineer interested in simulated service testing. The nuclear power reactor has created a new "jungle" rich in opportunity but not without pitfalls for the unwary. This article attempts to define some of the characteristics of the terrain.

The last fifteen years have seen the birth and growth of a new technology unparalleled in any like period in the history of science. Since Fermi and his associates constructed the first critical reactor at the University of Chicago in 1942, developments in this field have approached in scope and technological methods those advances achieved in other fields only after many decades of research and development.

It is true that the impetus for this rapid development was a direct result of World War II and ensuing international relations. It must also be recognized that these same conditions necessitated a secrecy policy which has affected the rate of development of the art. The decision of the Atomic Energy Commission in 1954 to declassify a large amount of information has led to a vigorous expression of interest on the part of industry. One result has been the rapid publication of vast quantities of uncorrelated information. A considerable effort must be made to summarize in useful form those data that are pertinent to each of the many fields encompassed by nuclear engineering.

This article is not intended to be definitive as to the relationship between reactor technology and environmental testing. It merely attempts to present some of the salient problems introduced by this new environment and some of the partial solutions that have been achieved.

Reactor Applications

Reports at the recent Geneva and Cleveland conferences indicate quite strongly that considerable time will elapse before nuclear energy will become competitive in the cheap power field. The principal need for power reactors in the United States during the next several decades appears to lie in those areas where cost of power is secondary to the availability of relatively unlimited power supply from compact, self contained power plants independent of logistic problems. Thus the immediate future for reactor power lies specifically in those areas that created the initial requirement for environmental testing; that is, tactical environments for aircraft, surface vessels and submarines as well as remote arctic, tropic, desert, and mountain locations; in fact in all places where the environment itself is the principal deterrent to the installation of natural or chemically fueled power plants.

While the sole *new* factor of environment peculiar to reactor systems is that of radiation, both temperature and corrosive atmosphere problems are severely aggravated under normal conditions of reactor operation. Moreover it is expected that other variables such as vibration or fatigue resistance will be considerably influenced by the interaction of these other variables.

Temperature

The nuclear reactor is essentially a heat source. The significant difference between nuclear and conventional heat sources is that the "theoretical flame temperature" of the nuclear fuel element is not limited to 3,000 or 4,000°F, but is of the order of millions of degrees. If suitable containment materials or techniques were available, operating temperatures of several million degrees F would be practicable. It is expected that fusion reactions may require temperature of this order of magnitude and work is being done to develop systems to operate under these conditions.

Thus we see that a high efficiency power plant, particularly for portable or mobile operation, will operate at ever-increasing temperatures as the technology improves. It is reasonable, then, to expect equipment operational temperatures in the immediate reactor vicinity to be at least as severe as those anticipated for the Inter-Continental Ballistic Missile, probably of the order of 1,000 or 1,500°F. The significance of this is obvious to the environmental test engineer.

Corrosive Atmosphere

The striving for high operating temperatures has led the nuclear engineer to investigate and develop a number of reactor systems that might normally be considered somewhat exotic. Gas cooled reactor systems in aircraft

might for example have ceramic or cermet surfaces at several thousand degrees F cooled by high-velocity low-temperature gas. In addition to the thermal shock problem, erosion is certainly a controlling variable under these conditions. High-pressure steam or super-critical water present other corrosion problems. One of the most promising approaches in high-temperature operation — and one of the most serious from the corrosion standpoint — lies in the use of liquid metals as heat transfer media.

Compromise between good thermal properties and good nuclear properties (low cross-section and short-lived radioactivity) has caused sodium and sodium-potassium mixtures to be considered currently as the best available liquid-metal coolants. Liquid sodium is relatively inert except in the presence of air or water. Unfortunately these materials are present in all of our environments and the resultant reactions are likely to be more severe than nuclear explosion from runaway reactors. The status of this art is well described by Admiral H. G. Rickover in his foreword to the *Liquid Metals Handbook*.[1]

"Although an impressive amount of data has been assembled on heat transfer, convective flow, thermal stress, thermal shock, and other phenomena important to the use of liquid metals in nuclear reactors, one can still not evaluate dependably these effects in a complex system. These problems have been attacked analytically, and experimental data have been correlated impirically. You will find the results of both kinds of approach in this book; but we do not yet know how to calculate with confidence a practical system.

"Although a lot of equipment has been designed, tested, and built to handle liquid metals, no dependable design rules have yet been developed to guarantee that the next pump, valve, or heat exchanger can be installed in a system without testing and still perform satisfactorily . . . Some guidelines have emerged from this experience and these are arranged to be of maximum usefulness to the designer, operator or purchaser of liquid metals equipment. But they do not guarantee that equipment so designed will work as intended . . . In the liquid metals field there is still no substitute for testing . . . Many applications of 'good design practice' and 'reasonable heat transfer assumptions' have proved dead wrong and many important problems have been overlooked. **With the present state of the art thorough testing is still required to bring out the inadequacies of the present design guidelines."**

Much is currently being done to advance the technology of liquid metal handling and circumvent the brute force approach to equipment and materials testing. While liquid metal systems are subject to all of the types of corrosion found in more common systems, some of the mechanisms of corrosion are peculiar to high temperature flow systems and appropriate testing techniques are constantly under development.

An unusual type of corrosion known as thermal gradient mass transfer occurs in systems employing liquid metals as flowing coolants with fairly large temperature differentials. The mechanism is essentially one of solution of the container material in the hot part of the system and deposition in the colder sections. Since pumps, valves and fittings are frequently located in the cold section of these systems, partial or total clogging with resultant malfunction may result. It should be noted that the "cold" part of the system may be at temperatures in excess of 1,000°F. This phenomenon is generally evaluated by means of thermal convection or forced convection (pump) loops.

The loop consists of a closed circuit of tubing or pipe fabricated from the containment material in question. It is generally instrumented for temperature at various locations, calibrated for flow, and designed to permit measurement of mass transfer as well as other corrosion phenomena. Flow in the thermal convection loop is caused by density differences in the system due to artificially created temperature differences. Heat is added to the "hot leg" of the loop by means of electric heaters and the temperature of the "cold leg" is controlled by adding or removing insulation. Flow rates in thermal convection loops are of the order of 2 to 10 feet per minute. A more detailed description of technique is available in a recent paper by Hoffman and Manly of Oak Ridge National Laboratory.[6]

The forced-convection loop is, in general, an elaboration of the thermal loop with regard to instrumentation and includes a pump to provide flow rates approaching operational conditions. Testing in forced-convection loops is more expensive than in thermal loops and is generally reserved for evaluation of systems showing promise under preliminary testing.

Figure 1 shows a high temperature forced convection loop designed to investigate mass transfer and other corrosion phenomena in containment materials for liquid metals.

Figure 1
Forced convection liquid metal test loop.

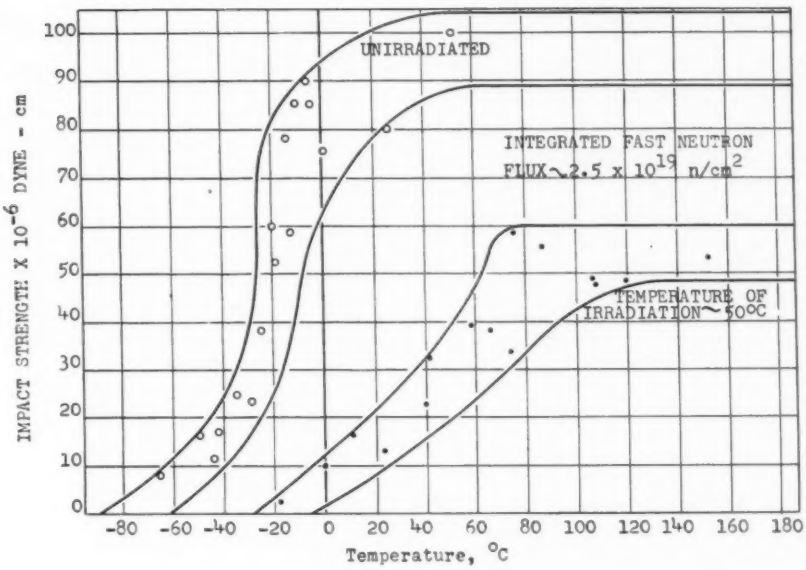
UNIRRADIATED
INTEGRATED FAST NEUTRON FLUX~2.5 x 10^19 n/cm^2
TEMPERATURE OF IRRADIATION~50°C
IMPACT STRENGTH X 10^-6 DYNE - cm
Temperature, °C

Figure 2

The effect of reactor irradiation on the impact strength of SA-70 pressure vessel steel. (Proceedings of the International Conference on the Peaceful Uses of Atomic Energy, August 20, 1955, Vol. VII, p. 747.)

Radiation

Irradiation is probably the least predictable of all factors contributing to reactor environment. The most significant effects are caused by neutron and fission fragment damage during operation, although gamma radiation before and after shut-down may be important for certain types of equipment. The effects of radiation (neutron and gamma) on personnel are in general both predictable and regrettable. "Radiation damage" to materials is neither completely predictable at present nor in all cases detrimental to the material.

In general, **radiation** produces an increase in hardness and strength and a decrease in ductility similar to cold-working in most metals (Figs. 2 and 3). Plastics generally undergo chain-breaking and cross-linking with indeterminate change in physical properties. Some of these effects can be annealed out by heat treatment while other changes are permanent. Whether these changes are beneficial or detrimental is resolved by the application of the material. A structural member in a stationary reactor may be stronger after irradiation. On the other hand, material subjected to vibratory stress can have its resistance to vibration lowered to the point of immediate failure if subjected to sufficient radiation. *Radiation damage is cumulative* and hence considerable effect may result from extended exposure at relatively low levels.

Electronic equipment appears to lose reliability in the presence of strong radiation fields although detailed data on this phenomenon are lacking. Some reasons for reliability loss are typified by the radiation characteristics of graphitic carbon. Figure 4 shows the effect of radiation on the electrical resistivity at various temperatures. The resistivity increases considerably with radiation exposure

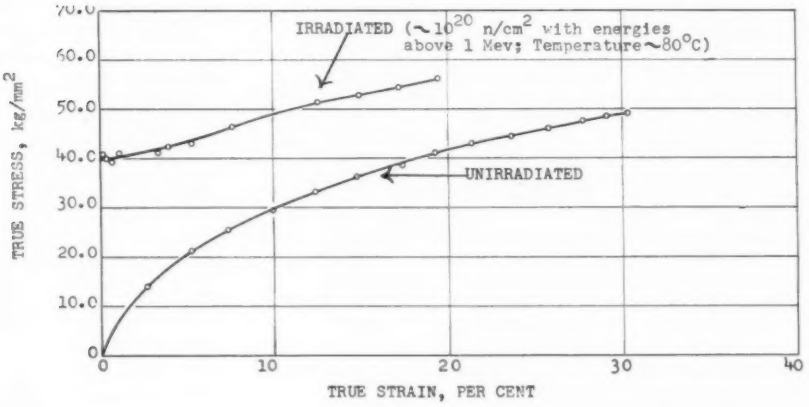

Figure 3

The effect of reactor exposure on the stress-strain curve of nickel. (Proceedings of the International Conference on the Peaceful Uses of Atomic Energy, August 20, 1955, Vol. VII, p. 747.)

but the effect is much less pronounced at higher temperatures. Change in Young's modulus for the same material is shown in Figure 5. The long-term effect on a carbon brush or resistor at −100°F in a strong radiation field is self-evident. Too few data are presently available to predict with any certainty the effect of radiation on specific materials or end items. Each case must be evaluated at present by means of its own test program. High-

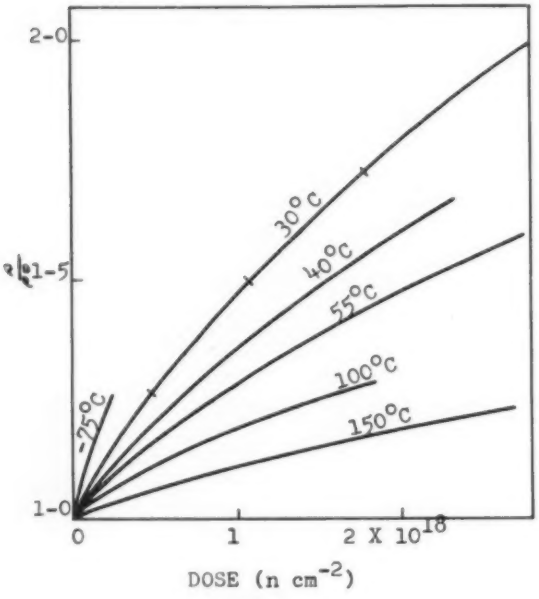

Figure 4
Changes of electrical resistivity at different irradiation temperatures. (Proceedings of the International Conference on the Peaceful Uses of Atomic Energy, July 1, 1955, p. 442.)

level radiation exposure is commonly performed in a test reactor such as the Materials Testing Reactor at Arco. Measurement and control of the specimen while under irradiation is complex and is usually accomplished by placing the test sample in a controlled atmosphere capsule similar to the one shown in Figure 6.

The test equipment manufacturer will also be faced in the next few years with problems concerning radiation. These will pertain not only to equipment reliability but also to personnel safety from the shielding view point. Shielding for reactor testing is in itself a complex science. Many of the excellent gamma shields, such as lead, are transparent to neutrons while many neutron shields are almost totally without effect on gamma radiation. Very

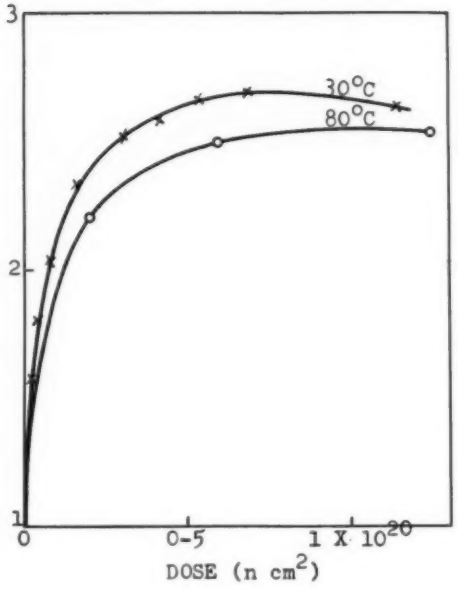

Figure 5
Changes of Young's Modulus at different irradiation temperatures. (Proceedings of the International Conference on the Peaceful Uses of Atomic Energy, July 1, 1955, p. 442.)

little effort has been expended in the design of equipment for combined nuclear and environmental testing. The best ideas of engineers in both of these fields will be required to generate a satisfactory solution to the problem.

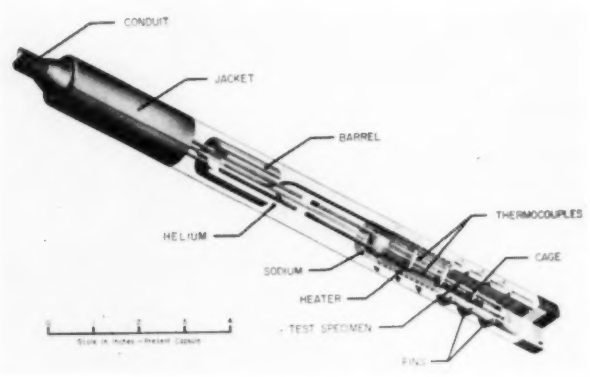

Figure 6
NDA irradiation capsule.

Much has been done in the atomic energy field to insure operational reliability of reactors, reactor systems, and reactor components. The secrecy requirements of the AEC program combined with the limited publicity given to the development of the environmental testing field has limited cross-pollination of knowledge and technique between these two fields. The future of reactor development can be much enhanced by the application of the experience gained in all fields of environmental testing to the requirements of nuclear power. The challenge is one that must be met by manufacturers of test equipment and by environmental test engineers alike.

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New Environmental Test Facility

As explained in a new brochure, Parameters, Inc., now offers complete environmental test facilities for complying with Military Specifications MIL E-5272A. As a design and development organization, Parameters is qualified to analyze malfunctions and offer recommendations for improving product operation. Parameters is equipped for setting up and functionally testing equipment while it is undergoing environmental test. Parameters maintains a complete jet fuel, hydraulic, electronic, and mechanical test facility to provide a "one-stop" testing organization. For more information, circle No. 361, page 13.

Fehr Appointed Head of G.E. Lab

Dr. Robert O. Fehr, international authority on acoustics and vibration, has been appointed manager of G.E.'s Mechanical Engineering Lab.

Dr. Fehr chairs an ASA committee on instrumentation for vibration and shock measurements and is supervisor of ASA's vibration activities.

A native of Berlin, Germany, Dr. Fehr attended the Swiss Federal Institute of Technology in Zurich, receiving his doctorate in electrical engineering in 1938.

editorial

The IEE Is Born

As this issue goes to press, the Environmental Equipment Institute is in the process of generating a new and vigorous engineering and scientific association—the Institute of Environmental Engineers. A brief account of how this came about appears on pages 12 and 13.

The IEE promises to fill a long-felt need for a meeting place of ideas for a fast-growing new profession — Environmental Engineering. This issue of the *Environmental Quarterly* is the face and voice of both Institutes. The *Environmental Quarterly* is destined to take its proper place in American technical journalism, but — like the two Institutes it represents — it is in its adolescence.

For it to fulfill its obligations to science and industry, it must have your help. It needs an overflowing file of high-calibre articles of general and technical interest in all phases of environmental science, engineering and testing. This it does not have. You — the people who specialize in the environment — can fill this need.

Share your specialized knowledge with us. Give us your ideas and topics for possible articles. Tell us what *you* want to see in the magazine. Give us your comments on this issue.

The *Environmental Quarterly* will grow and improve only in proportion to the two-way communication between you and its pages.

IEE Plans Annual Science Meeting

The new-formed Institute of Environmental Engineers has set the dates of April 25 and 26, 1957, for its first annual science meeting, according to Mr. Henry F. Sander, Provisional President.

Mr. Sander stated that the meeting is scheduled for the La Salle Hotel in Chicago and that he expects to be able to announce something definite about the program in time for the October issue of the *Environmental Quarterly*.

HENRY F. SANDER, President

ROGER J. AMOROSI,
Executive Vice President

HAROLD C. JONES,
Secretary-Treasurer

SANDER. Chief Test Engineer, Vapor Heating Corporation. Member Society for Experimental Stress Analysis and Instrument Society of America. Attended Illinois Institute of Technology and Northwestern University.

AMOROSI. President, and coordinator of engineering and test projects, Parameters, Inc. Member New York State Society and National Society of Professional Engineers. BS and MS, Electrical Engineering, Cornell 1948 and 1950.

JONES. Senior Engineer, Environmental Test Section, Air Arm Division, Westinghouse. Member American Institute of Electrical Engineers. BS, Electrical Engineering, Illinois Institute of Technology, 1949.

Institute of Environmental Engineers Formed

In an extraordinary joint meeting of the Science Section of the EEI and the Institute's Executive Committee in New York City on June 8th, a new scientific and engineering association was voted into existence. To be called the "Institute of Environmental Engineers," and to be incorporated under its own charter, the new group will remain, for the time being, a close partner of the parent organization – the Environmental Equipment Institute.

Created originally under the science program of the EEI, the Science Section had gained such stature by the time of its Second Annual Meeting in April (article on page 19) that a movement toward complete autonomy became inevitable.

It was the sentiment of the members of the Executive Committee, expressed by Mr. Charles E. Earl, President of EEI, that the Institute of Environmental Engineers could eventually develop into a powerful instrument for the advancement of science and that every effort should be made to make this come about.

The joint meeting, chaired by Mr. Ray H. Mattingley on behalf of Mr. George D. Wilkinson, General Manager of the EEI, after agreeing to the formation of the new corporation, proceeded to select a name for the new association and to elect a slate of provisional officers.

Dr. David Leibowitt, Counsel for the EEI, serving as legal advisor to the meeting, was instructed to proceed with incorporation action and to draft by-laws for the new Institute.

The provisional officers elected to serve upon incorporation of the IEE and until a general election is held are: Mr. H. F. Sander, President; Mr. Roger J. Amorisi, Executive Vice-President; and Mr. Harold C. Jones, Secretary-Treasurer. Three other men were elected to serve as members of the Executive Committee: Mr. Newell Mecartney, Mr. Earle G. Foote, and Mr. Irving P. Polak.

Following the election, Mr. Sander assumed the chair and the provisional organization of the new IEE held its first session.

IRVING P. POLAK, Member

NEWELL MECARTNEY, Member

EARLE G. FOOTE, Member

***POLAK.** Section Supervisor, MJL Operations, Marquardt Aircraft Company. Formerly project engineer, Aero Engine Lab, Naval Experimental Station. BS, Mechanical Engineering, Pennsylvania State University, 1942.*

***MECARTNEY.** Electrical Engineer in charge of Test Facilities Design, Jack and Heintz, Inc., until recently. Formerly with Packard Motor Car Co. and Allis Chalmers Mfg. Co., BS, Electrical Engineering, Fenn College, 1954.*

***FOOTE.** Mechanical engineer in charge of a Lab Facility Development Group, Instrument Development Unit, Boeing Airplane Company. Formerly with the MIT Servomechanisms Lab and with University of Washington as instructor. MS, Mechanical Engineering, MIT, 1946.*

Mr. Sander appointed Mr. Amorosi to collaborate with Mr. Leibowitt in the preparation of technical papers required to complete the incorporation. In addition, he appointed a Publications Committee to work with the editor of the *Environmental Quarterly* in acquiring a reserve of high-quality editorial material. This Committee consists of: Mr. Norman Meyers, Stratos Division, Chairman; Mr. David Askin, Frankford Arsenal; and Mr. Ralph R. Ferry, Allied Control Company.

Photographs of the provisional officers, with brief biographical information, appear at the top of these pages.

Following is a list of others in attendance at the joint meeting: Mr. E. S. Brown, Standard Cabinet Co.; Mr. Saul S. Schiffman, Tenney Engineering, Inc.; Dr. Alan E. Surosky, Nuclear Development Corporation; Mr. James Scibetta, Bowser Technical Refrigeration; Mr. John R. Messera, Emerson Research Laboratories; Dr. Robert L. Stallard, General Electric Corporation, and Mr. S. D. Danko, Motorola, Inc.

FOR MORE INFORMATION on products and literature described in this issue, "circle" the key number and mail this coupon to the editor, *Environmental Quarterly*.

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Role of an Environmental Department

By JOHN CAMMARATA, American Bosch Arma Corporation

The demands for continued satisfactory performance of electrical and electronic products under extreme conditions has made "environmentalization" an important function of design engineering. Jet aircraft and flight-controlled missiles, because of their high speed at high altitudes, have vastly accentuated the need for designing for extreme environmental conditions. This article reviews the organization and integration of an environmental department into an engineering and manufacturing organization. The viewpoint is that of a producer of electrical and electronic products for the armed forces, but the principles discussed are applicable to civilian producers as well.

ENVIRONMENTAL TESTING HAS IN RECENT YEARS become very important in specifications governing the manufacture of much electrical and electronic equipment. Reliability at the environmental extremes of jet and missile flight has focused attention to an even greater degree on such testing. Particularly, attention is drawn to military equipment which is commonly exposed to environments such as low temperature and high altitude. Civilian equipment is exposed to the same design thinking insofar as environmental conditions are concerned. However, the same terms are not used nor is the emphasis as great because of the gradual change of seasons (environment) and the conditions of exposure are to some degree more controllable.

Personnel

With the acceptance of "environmentalization" as an important design factor, there is the need for incorporating suitable design principles into equipment and proving them. Engineers must be trained in these concepts but, up to the present, there has been no formal training in engineering colleges. Most of the background must be gained by individual field experience and by study. Ideally, engineers to staff an environmental department should be familiar with the design and development of the equipment in question and have field experience in the use and service of the product.

In organizations having many engineers, it is possible for the environmental department to have a staff of specialists to carry out investigations and tests on various projects. For small companies, one engineer may be assigned to conduct environmental investigations, either full time or part time as required. The environmental department, consisting of one engineer or many, serves as a clearing house and consultant on environmental design, development, and testing.

Test Equipment

Test equipment requirements will be determined by the use, frequency and complexity of the product to be tested. For small concerns which may have only infrequent periods of testing, relatively simple self-made equipment may be satisfactory.* This permits small manufacturers to develop and test their products with a relatively small investment. Where such equipment cannot be improvised, commercial test laboratories may be used. Where the work load of continual product development and sampling production tests warrant it, commercial equipment may well be purchased. This is especially true for large engineering and manufacturing concerns having an environmental department as an independent group.

In recent years the demand for many different types of environmental equipment for such tests as temperature, humidity, altitudes, fungus, salt spray chambers, shock test equipment, vibration test equipment, acceleration test equipment and the like has been so great that many small companies have been formed to produce them.

Role in Bidding

The role of the environmental department is such that it contributes an active engineering team member from the preliminary bidding phases through to the time that prototype and production units are shipped. In the first stages during which a proposed contract is studied prior to submitting a proposal and bid, the environmental department reviews the specifications to determine the effect of environmental requirements on design. Specifications are reviewed from the standpoint of determining realism.

Abstracted from the October 1955 issue of Electrical Manufacturing, "Role of an Environmental Department," by John Cammarata.
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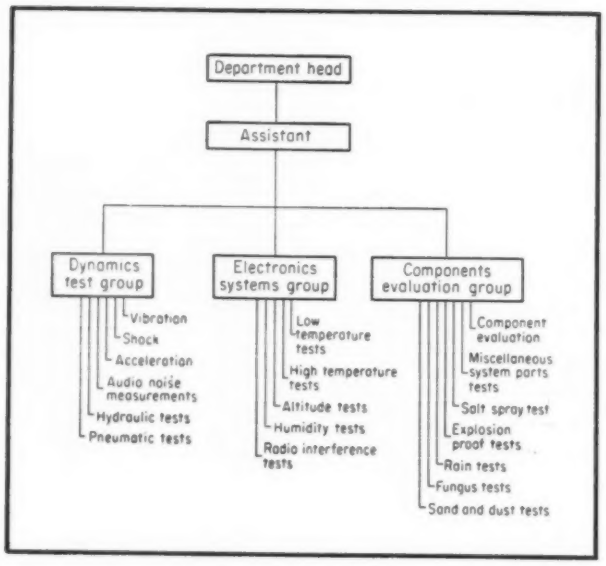
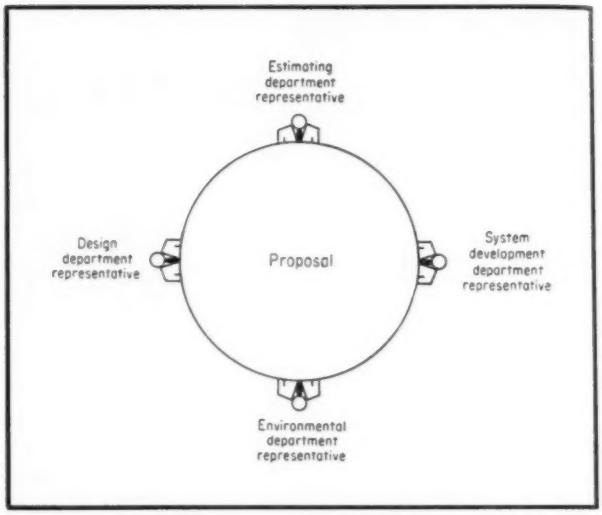
"Environmental Testing of Components Need Not Be Expensive," D. L. Lane and J. C. Wightman, Electrical Manufacturing, May 1952, P. 118.



Organization chart for environmental department for a manufacturer of electrical or electronic equipment.



During proposal stage, an environmental department representative confers with those of design, system development and estimating departments.

Too often specifications are set up on the basis of taking portions of one product and portions of another with little regard for the particular service requirements. It is here that a qualified environmental engineer can save his company from the embarrassment of having to say that they cannot meet certain specification requirements after receiving the contract. Frequently, interpretation of specifications is required to translate an environmental condition to design language. For example, a specification may require a product to withstand an underwater explosion of a certain type of depth charge at a certain distance. What does that mean to a mechanical engineer? An experienced environmental engineer can translate that to a shock impulse which then provides a basis for design. Also, a particular design approach may require certain components that are known to be inherent radio noise generators and therefore require extensive filtering and shielding to meet specification. The environmental engineer may point out the possible pitfalls encountered in the use of these units and thereby avoid unforseen extra costs.

In preparing the proposal for bidding, the environmental department may submit its report for inclusion in the overall presentation. Usually this report is a resume of the company facilities and a schedule of the test work. Generally, the production test procedure and test equipment are not directly applicable to testing the products under environmental conditions. When special test procedures and test equipment are required, the environmental department specifies them for the proposal.

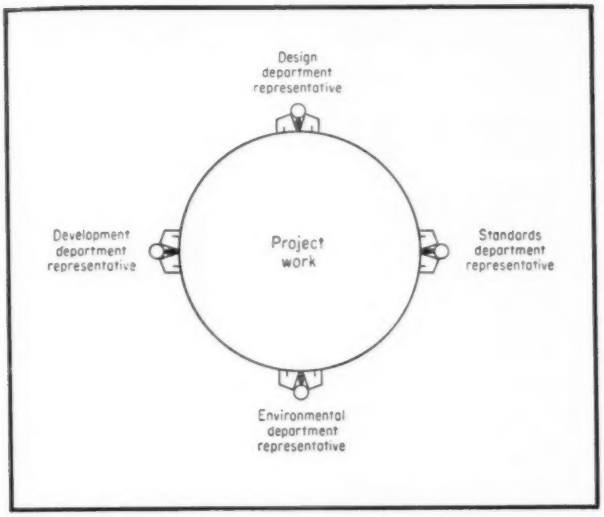
Needless to say, the capability of component parts to be used in the overall system must be known. This is very important in the preparation of the company proposal.

After Contract is Obtained

When the contract is obtained and active engineering work started, environmental engineers are integrated into the project. Their work is paralleled with that of the standards department in the selection of components for the proposed design which will meet the environmental conditions of the specification. Work is carried on as a team with the project engineer, standards engineer, and environmental engineer designing tests procedures for questionable components.

The environmental engineer or team is available as consultants during the design and layout stages. For example, radio interference advice can save the designer much trouble by suggesting a layout that will confine interference signals to one section and without coupling it to outgoing leads. In addition, the selection and placement of filters, if such are required, should be done during the layout stage.

The preliminary qualification test procedures can now be settled in final form. Each condition of environment imposes its own peculiar method of testing and of test equipment and often is much different than the tests conducted in the production testing department. The environmental test engineer must be able to monitor performance of the equipment remotely. In conditions of temperature extremes it may be possible to have technicians enter the test chamber to make adjustments or readings. However, for conditions of altitude, vibration, shock, for example, operation of the equipment must be remote and so must instrumentation. Frequently modification of production test equipment is possible, but in some cases completely different test equipment is needed. The qualification test procedure then includes a step-by-



After the contract is obtained and active work starts, environmental engineers work with the design, development and standards departments.

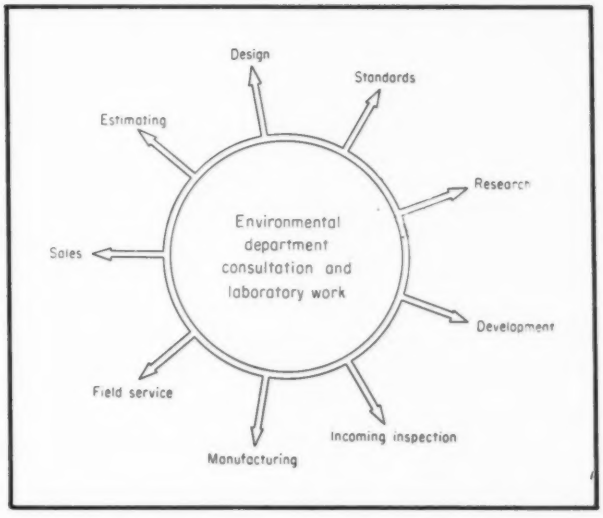


Diagram showing that the environmental department works with many other groups in an organization.

step approach to insure operation in accordance with the specifications and the environmental extremes.

Component qualification is carried on during the active development stage of the projects. Assurance that the components individually pass environmental tests is the best insurance that the completed instrument will pass the environmental tests. The component test program, however, must be modified by reasonable engineering judgment. Where commercial parts have been attested to have passed environmental tests by the manufacturer, there is little need to re-run the tests. Nevertheless, up to the present time, very few commercial items have been available that meet all the stringent military specifications.

This condition has existed for two reasons. The first is that the commercial field has not kept pace with the rapid advancement of the military and, secondly, many manufacturers have not had environmental facilities or personnel to run the tests. Their product is usually offered "as is" and is not represented to meet any particular environmental specifications. The manufacturer says that it was designed to meet the environmental specifications on paper but was not tested. The importance of this phase of the project cannot be over-estimated. The time and embarrassment saved by avoiding component failure at final environmental test more than compensates for the effort made.

Where commercial or company-made products tested on a component level do not meet environmental specifications, the environmental department engineers work on the development of a product that does meet the specification. This can be done entirely within the department or in collaboration with the development groups, or on a consulting basis to the development group.

When the completed system is available for qualification tests, the environmental department subjects it to tests to be certain it meets the requirements of the specification. Engineers assigned to the project should be those involved in the preliminary proposal phase and who were active during the component test phase. Their close association with the project enables them to make an intelligent appraisal of the system performance under environmental extremes and to trouble-shoot if problems occur.

Progress reports of the tests are prepared and forwarded according to usual company channels. Liaison is maintained with government inspectors during the course of the tests when contacts with government agencies are required.

In some instances, major portions of the product may be subcontracted by the prime contractor since his plant and his experience may not qualify him to produce them. In those cases, the qualification of test procedures and other phases of environmental design are handled by the environmental department. Frequently, it is only to approve the qualification test procedure prepared by the subcontractor's environmental engineers. During the course of the qualification tests at the subcontractor's plant, the environmental department representative witnesses the tests and reports on the tests and the results. The complexity of the equipment, qualification test, and degrees of trouble encountered determine the need for a full-time attendant at the subcontractor's plant. A report of acceptable test results on the subcontractor's equipments as witnessed by the environmental department engineer should be adequate and the prime contractor need not re-run the tests.

Occasionally it is more economical and expedient, if not necessary, to run certain environmental tests in the actual installation. This is, of course, a function of the

environmental department. Several examples are listed here for illustration. The vibration specifications for a product may be so extensive that it is not possible to design the equipment and still have it perform its primary task without having several resonant points in the structure. Since it may not be possible to contradict the realism of the specification, it is often agreed that a waiver can be issued to accept the equipment in spite of not meeting the overall specification as long as the contractor agrees to perform whatever modifications are required after the installation.

This realistic approach saves money for the customer and contractor and eliminates having a monstrosity design because of a catch-all specification. The dynamics engineer of the environmental department then assures himself and the customer by the field tests that the equipment will meet all operational requirements. Often it is possible to damp out particular resonant conditions on the final installation by the judicious placement of weights or special mounts without introducing other resonant points as might occur on the vibration test table. This condition exists because the forcing function for the other resonant points on the final installation do not have the same magnitude as listed in the specification.

Another very important field test, in addition to tests in the laboratory, is for radio interference. The specification requires that the equipment must not interfere with other equipment and must not itself be susceptible to outside interference. Oftentimes, it is impractical or uneconomical to reduce interference in a product to specification limits which tend to be a catch-all. Certain inherent attenuation characteristics of cable runs can make the overall equipment installation noise free. On the other hand, it is possible that the combination of existing noise in the contractor's equipment, even though within the specification level, may affect or be affected by other equipment because of a resonant condition which may result with the cabling and other parameters. This condition cannot be effectively detected in the laboratory, if at all. In addition, adjacent cable runs may couple-in interference signals or may have interference coupled into them. This condition is virtually impossible to simulate in the laboratory. This type of field work calls upon the training and ingenuity of the radio interference expert who is part of the environmental department.

Other Supporting Functions

Field service engineering may often call upon the environmental department to furnish a consultant on some special problem which the field service engineer, as experienced as most of them are, cannot solve because of the high degree of specialization. The vibration and radio interference problems mentioned above are good examples of the application. In addition, a recurrent deficiency in the field may be referred to the environmental department for investigation. For example, corrosion problems are difficult to pin point by observation only. Laboratory analysis is often required and simulated accelerated life tests on new sections are required to determine the cause of failure.

The addition of new equipment in an old installation may introduce a radio interference problem. The radio interference specialist is called upon to assist the field service engineer in tracking down the trouble. With the complexity of present day equipment, it is not practical to train the field service engineer to be an expert in all fields of specialty. The convenience of having a pool of specialists in the environmental department provides greater flexibility to the engineering division, faster and better service to the customer, and a better reputation to the contractor.

During the course of normal company developments to advance their standing in the state of the art and to improve their status in a competitive market, new products must be continually developed. The environmental department plays an important role in this phase of the company operations in the evaluation of new products. This is especially important for component manufacturers since the imposition of environmental requirements is mandatory in many cases. A cooperative program with the research department, development department and product engineering department puts the environmental department in a key position.

The environmental department among its other duties oftentimes goes outside the engineering division to assist the inspection and quality control groups. It is generally not economical to duplicate certain environmental test equipment in a plant even though division lines must be crossed.

Processed samples may require periodic sample testing to insure that the methods and materials used continue to produce a product which meets the specifications. Salt spray tests of anodized samples and plated samples, and pressure testing of castings are examples of work that the manufacturing department relies upon the environmental department to perform.

Summary

The environmental department's role in an engineering division can be best described by use of its descriptive title. It is as difficult to eliminate the activities of the environmental department from a well-organized engineering division as it is to produce environment free ambient conditions for the products designed. The recognition of the importance of a functionally operative environmental department introduces a tool of immense versatility into an engineering division. The accent on reliable operation of equipment at environmental extremes does not permit design of reliable equipment without environmentalization of the units. An organized approach to the problem, whether it be by one engineer in a small company or by a department with a staff of specialists and technicians in large engineering and manufacturing companies, will produce environmentalization economically.

Report on Second Annual Science Meeting of Environmental Equipment Institute

Vibration and Climatic Testing Emphasized

On April 19 and 20, a group of 330 scientists, educators, and engineers, representing industry, the Armed Forces, and technological education, assembled in Chicago to participate in the Second Annual Science Meeting of the Environmental Equipment Institute. With a brilliant array of speakers, and arranged in four technical meetings and four discussion seminars, this symposium brought together a vast amount of knowledge in the field of environmental science, testing, and simulation. Special emphasis was placed on vibration and climatic testing and instrumentation.

Each paper and each seminar panel discussion was followed by a vigorous question-and-answer period, during which, by means of roving microphones, a tape recording was made. These question-and-answer recordings are to be published in edited form as a part of the "proceedings" of the Science Meeting.

In addition to the general program, visits were made to the Armour Research Foundation of the Illinois Institute of Technology. Representatives of the Manufacturing Members and Associate Manufacturing Members of the Institute held technical conferences to discuss individual environmental equipment problems with all who were interested.

Mr. Charles Earl, President of Alpha Electric Refrigeration Company, delivered the welcoming address on the first day. His subject was the objects and functions of the Environmental Equipment Institute.

Meeting Engineered by Sander

The Second Annual Science Meeting of the EEI was planned, organized, and operated by a committee headed by Mr. H. F. Sander, Vapor Heating Corporation, in conjunction with Mr. George D. Wilkinson, General Manager of the Institute. Mr. Sander was assisted by the other members of the Science Section Steering Committee: Mr. Roger Amorosi, Parameters, Inc.; Mr. Earl G. Foote, Boeing Airplane Company; Mr. Harold C. Jones, Westinghouse Electric Corporation; and Mr. Newell Mecartney, Jack and Heintz, Inc.

Proceedings to Be Published

The "Proceedings" of the Science Meeting are being prepared for publication and are expected to be ready for distribution by autumn to all who attended, as well as to other science members of the Institute. Although no price has been established, a limited quantity of the "Proceedings" will be placed on sale after the basic distribution has been made.

Scope of Meeting

To show the scope of the Science Meeting and of the "Proceedings," an outline of the program presented is printed below.

Outline of Science Meeting Program

TECHNICAL MEETING

Chairman, Mr. Monroe Seligman, President,
Tenney Engineering, Inc.

Paper: "Fungus Frustrates Fanatics," presented by Mr. William Vandal for Mr. W. S. Osborne, both of North American Aviation, Inc.
This paper covers the purpose, technique, test procedure, test conditions, test chamber construction, and health aspects of fungus testing.

Paper: "High Speed Photography in Environmental Testing," by Mr. P. E. Atkinson, Westinghouse Air Arm Division.

SEMINAR I: VIBRATION INSTRUMENTATION

Meeting Chairman: Mr. Albert J. Deeb, Sales Manager, International Radiant Corporation.

Panel Chairman: Dr. Irwin Vigness,
Naval Research Laboratories.

Panel Members:
Mr. Abraham I. Dranetz, Gulton Maufacturing Co.
Mr. J. McDonald, Consolidated Engineering Corp.
Dr. T. Perls, Lockheed Aircraft Corp.
Mr. Donald J. Shergalis, Grumman Aircraft.

SECOND TECHNICAL MEETING

Chairman:
Mr. Charles Earl, President,
Alpha Electric Refrigeration Company

Paper: "Standardization Planning for Environmental Testing," Mr. E. F. Seaman, Department of the Navy.
Molding our future effort into a direction that will return the greatest benefits in return for the expended effort.

Paper: "The Design of a Small Environmental Test Facility," Mr. William Tonkowich, General Testing Laboratories.
What the small manufacturer should know before setting up a laboratory.

SEMINAR II: PHILOSOPHY OF VIBRATION TESTING

Meeting Chairman:
Mr. Jack Shamroth, President,
American Research Corporation.

Panel Chairman:
Prof. J. P. Den Hartog,
Massachusetts Institute of Technology.

Panel Members:
Mr. M. Comuntzis, California Institute of Technology.
Dr. C. Morrow, Ramo-Wooldridge Corp.
Mr. J. Ross, L. M. Electronics.
Mr. Robert Stallard, Johns Hopkins University.
Mr. R. G. Yaeger, Bell Aircraft Corp.

THIRD TECHNICAL MEETING

Chairman:
Mr. C. M. Shelburn, Vice-President,
Webber Manufacturing Co., Inc.

Paper: "An Acoustical Vibration Facility," Mr. Paul T. Sauber, Boeing Airplane Co.

Paper: "Vibration Testing to MIL E 5272 Requirements," Mr. D. C. Kennard,
Wright Air Development Center.
Outline of background for establishing the MIL E 5272 vibration testing procedures and description of techniques for conducting specific tests.

SEMINAR III: FUTURE TRENDS OF CLIMATIC TESTING

Meeting Chairman:
Mr. R. J. Jacobson, President,
Cincinnati Sub-Zero Products.

Panel Chairman:
Mr. W. L. Holladay, Holladay and Westcott.

Panel Members:
Mr. James Allen, Westinghouse Electric Corp.
Mr. Frank Cherry, York Corp.
Mr. Bernard Friedman, Tenney Engineering, Inc.
Mr. Robert Lusser, Redstone Arsenal.

FOURTH TECHNICAL MEETING

Chairman:
Mr. E. S. Brown, President,
Standard Cabinet Company.

Film: "Mt. Washington Icing Facility."

Paper: "Factors of an Environmental Program," Mr. John R. Grimm, Wright Air Development Center.
Definition of environments, establishment of requirements, test procedures, and facility needs.

Paper: "Radio Interference Tests and Control Requirements," Mr. William Jarva, U. S. Naval Air Development Center.
Types of tests required, instrumentation, accessories, and measuring techniques.

SEMINAR IV: CLIMATIC INSTRUMENTATION

Meeting Chairman:
Mr. C. E. Harris, President,
Harris Refrigeration Co.

Panel Chairman:
Mr. W. L. Holladay, Holladay and Westcott.

Panel Members:
Mr. K. R. Knoblauch, Brown Instruments Co.
Mr. C. E. Ohlheiser, American Instruments Co.
Mr. Ronald Reamer
Taylor Instrument Companies.

Instrument Society of America Host to EEI Science Members

The Chicago Section of the Instrument Society of America extended an invitation to Members of the Science Section of the Environmental Equipment Institute to attend their May meeting in Chicago.

At the meeting, Mr. Vernon Walter, Inland Testing Laboratories, presented a paper on "Instrumentation Automation for Environmental Testing." Mr. Walter explained methods of conducting continuous environmental life test programs, using programming controls to remove data from components under test, and demonstrated a number of techniques for recording such data.

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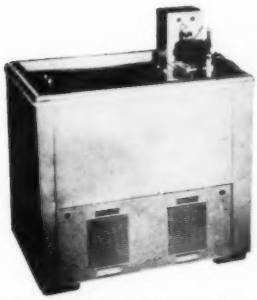
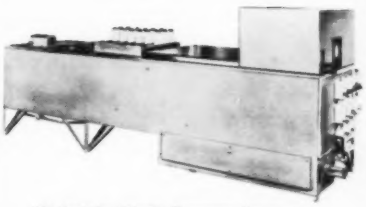
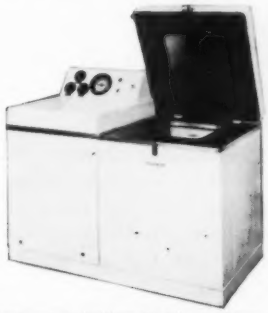


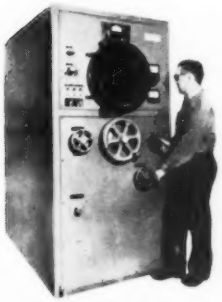
Constant Temperature Bath temperature range from —50°F to +200°F.



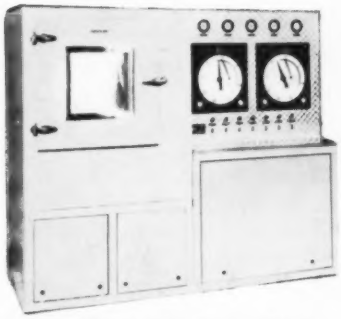
60 bottle Shell Freezer for processing human blood plasma.



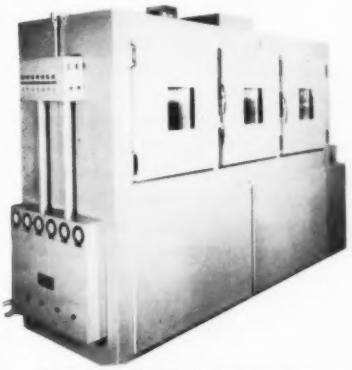
Horizontal Utility Cabinet. Temperatures to —150°F. Standard sizes 3, 6, and 9 cu. ft.



Ionosphere Chamber altitudes to 350,000 ft. (0.1 micron) used for testing guided missile parts.



Humidity Temperature cabinet. Temperature range —100°F to +200°F. Humidity Control 20% to 95%. Sizes from 5 to 48 cubic feet.



Custom built dual temperature 3 compartment test chamber for operations to —150°F.

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New Products

New Psychrometer

A 2½ pound motor-driven psychrometer for determining relative humidity has been developed by the Friez Instrument Division of Bendix Aviation Corporation.

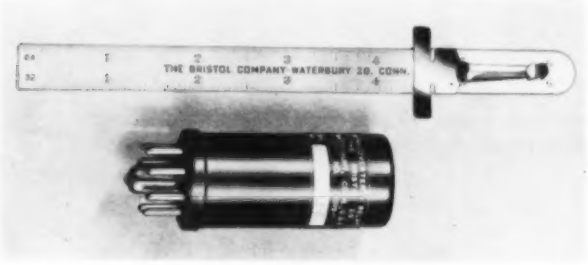
The Psychron was designed to government specifications for use by the U. S. Weather Bureau. In addition to its meteorological application, the commercial model will be useful in many other fields where temperature and humidity must be closely checked or controlled – such as environmental testing, air conditioning, refrigeration, etc.

The Psychron, powered by three flashlight batteries, consists of a matched wet- and dry-bulb thermometer assembly ventilated by a tiny fan coupled to a motor. The thermometers attain an accuracy of plus or minus 0.3°F at any point. The Psychron operates in a relative humidity range of from 10 to 100 per cent, and a temperature range of from 10 to 100 degrees F.

Advantages of the Psychron include easier and safer close-quarter operation and more precise aspiration rate. It also is immune from radiation effects of the sun and has a built-in thermometer illumination system.

The complete commercial unit is expected to be available by fall.

For additional information, circle No. 341, page 13.



High-Speed Syncroverter Relay

A new high-speed relay has been announced by The Bristol Company of Waterbury, Connecticut. Designed for complete reliability in dry-circuit and low-power applications, operation of the Syncroverter Relay is unaffected during shock of 30G, and vibration (10-55 cps) of 10G. It is normally furnished for mounting in a standard octal tube socket.

Typical performance characteristics include: Temperature range, −55° to +100°C; contact ratings, up to 28v, 200 ma; pull-in time (including bounce), as low as 200 microseconds; drop-out time, 300 microseconds; stray contact capacitance, less then 15 mmfd. Under these conditions, life expectancy is at least 1000 hours at 400 operations per second.

For additional information, circle No. 351, page 13.

Environmental Frontiers

"Learning Environment" Simulated at Air Force Academy

To help engineers, scientists and military officials find an "indoor climate" in which cadets will learn most effectively, a research program – first of its kind in military history – is being conducted on the site of the Air Force Academy at Colorado Springs, Colorado.

Details of the experiment were disclosed by Air Force Secretary Donald A. Quarles after a tour of the Academy site and a review of preliminary findings of the Air Force Academy Construction Agency and Minneapolis-Honeywell Regulator Company, who are cooperating in the studies.

Two 13-by-18-foot dormitory rooms have been built as exact duplicates of the quarters that will house the Academy's 2,600 cadets on the 17,500-acre site.

The rooms are equipped with sensitive Minneapolis-Honeywell and Air Weather Service research instruments that read and record air temperatures at six points, and chart the effects of the sun, air movement, humidity, and other conditions that affect human comfort and efficiency. The rooms are also furnished with automatic temperature controls so indoor conditions can be regulated and the effects of the changes recorded.

This data will be supplemented by reports from Air Force Second Lieutenants who are living in the "environmental rooms" and carrying out duties such as Academy cadets will perform.

The project is under the supervision of Col. Albert E. Stoltz, Director of the Air Force Academy Construction Agency, which has the mission of constructing the modern service school.

Instruments used in the unique experiment include a radiation detecting device called a two-sphere radiometer developed by Honeywell research scientists to study the effect of sunlight on residential, school, office and factory heating and air conditioning. Consisting of two dissimilar sensing elements, it measures and records the effect of sunlight on inside temperatures, shows what happens indoors when the sun goes down or is obscured by clouds, and measures the gain or loss of radiant heat due to sunlight, bright skies, or cold walls and windows.

Environmental Lab Analyzed by EEI Local Chapter

"The Environmental Test Laboratory" was the subject of a panel discussion at a local meeting of the New York Metropolitan Chapter of the EEI Science Section on Friday, June 8. Approximately 50 persons made up the audience for the technical session that was officiated by Mr. Bernard Friedman of Tenney Engineering, Inc.

The topic was divided into these categories: Basic equipment, organization, equipment schedule policies, and equipment procurement policies.

In addition to Mr. Friedman, panel members participating in the discussion were: Mr. Walter Angell, Sperry Gyroscope; Mr. John Cammarata, American Bosch Arma Corporation; Mr. James Tabur, Radio Corporation of America; and Mr. Jay Ward, General Precision Laboratory.

Each speaker described the type of environmental test equipment employed in his company's laboratory and, in some cases, touched upon the historical development of the environmental laboratory.

With respect to organization, it was agreed that environmental testing was a specialized field and that the establishment of an Environmental Test Group was thus a necessity. Such a group would advise and assist other technical personnel in techniques of environmental testing. The group would also be responsible for keeping abreast of new equipment, procuring new equipment, and to keeping all activities informed of these developments.

In the light of the emphasis now being placed on environmental testing all speakers agreed that, to obtain maximum testing time on each piece of testing equipment, a schedule of testing time is a requirement. However, the schedule should be flexible enough to accommodate prior projects.

ISA Fall Symposium

The important subject of "Process Data Handling — Why, How, and Where?" is the theme chosen for the Philadelphia Section, Instrument Society of America, 1956 Symposium. This meeting will be held November 7 and 8 at the Bellevue-Stratford Hotel in Philadelphia.

The program of the two-day affair will incorporate papers and panel discussion by experts and specialists representing manufacturers and users of automatic control instrumentation. Main topics for consideration will be: why data logging is a vital phase of modern instrumentation, how it is accomplished and applied, where it is advantageously utilized.

Discussion sessions will be augmented by an "Instrument Fair" at which manufacturers will exhibit the latest automatic measurement, control and data handling equipment.

For further information contact Horace Richter, Symposium Chairman, Fischer and Porter Company, 29 Bala Avenue, Bala-Cynwyd, Pennsylvania.

Questions and Answers

In response to the Question in the April issue, Mr. Edward F. Noonan, of Noonan, Knopfle and Feldman, Professional Engineers, submits his comments on vibration and shock mounting.

Sir:

The vibration portion of MIL-T-17113 has been superseded by MIL STD-167 (Ships) dated Dec. 1954. The shock portion of MIL-T-17113 is still used for shock testing of electronic equipment.

Both shock and vibration tests require the equipment to be tested on the selected mountings. It is recommended that where possible, equipment should be designed to pass the prescribed tests without resorting to the use of mountings. When this is not possible it is recommended that either of the following features be incorporated in those mountings selected:

Mountings of sufficiently high natural frequency should be chosen so as to avoid resonance of the mounted system during vibration testing. This will reduce the effectiveness of the shock protection but avoid damage of the equipment in service as a result of resonant vibration. Of course, this applies to all modes of vibration.

If greater shock protection is required, necessitating lower frequency mountings, the selection of mountings should be limited to those displaying greater damping characteristics. It is desired that sufficient damping be incorporated in the mountings to avoid an amplitude magnification greater than three in all modes of vibration. Under some circumstances it may be possible to introduce additional damping by auxiliary means such as by the incorporation of mechanical dampers. It should be noted, however, that damping will increase the transmitted shock.

Can You Answer This One?

Sir:

AVCO's Advanced Development Division is in the process of procuring several high altitude test chambers for our laboratory. Because of the extreme low pressures to which equipment is subjected, it seems likely there would be danger from high-energy particles in the event of implosion.

The equipment manufacturers do not appear to be disturbed by this prospect; however, from the standpoint of safety, we are interested in determining if accidents of this type have occurred among users of high altitude chambers.

CHARLES COHEN
Associate Engineer
AVCO Manufacturing Corporation

NOTE: Please address replies to this month's question to the attention of the editor.

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can change your environment...

If you want to simulate *altitudes to 200,000 ft.* or more; if you need to *control temperatures* from extremely low *sub-zero* to *extremely high;* if accurate *control of humidity* is vital to your test results; if *controlled cycling* of any or all of these factors is helpful to you . . . then *WEBBER is a name to remember.*

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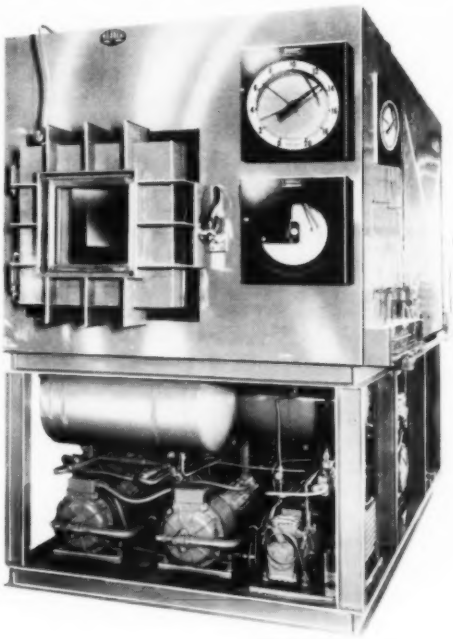

This Altitude Test Chamber was designed and built by Webber for Canadian Westinghouse to simulate altitudes to 150,000 ft., with temperatures controlled from —100 F to +250 F; Humidity from 20 to 95%. This type unit is available in sizes from small test compartments to large walk-in altitude rooms.

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Environmental Test Equipment for use in—
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For more information, circle No. 271, Page 13.

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quality improved — costs lowered by advanced environmental testing

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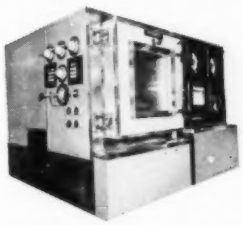
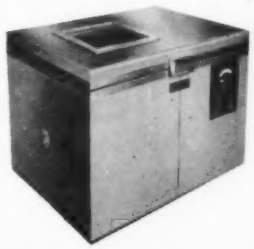
Do your products **really** deliver their rated performances at −100°F... at 150,000 feet altitude... at 95% humidity? Tenney-Testing environmental equipment gives you a complete record of performance under extreme conditions quickly, accurately... eliminates costly engineering and production changes. Environmental testing equipment for simulating **every** atmospheric condition is engineered and manufactured by Tenney. Altitudes to 200,000 feet +... temperatures of −150°F to +500°F... 10% to 100% humidity.

TENNEYZPHERE ALTITUDE CHAMBERS

Custom-engineered to simulate every atmospheric condition from sea level to 200,000 feet +. Temperature range of −150°F to +350°F.* Relative humidity of 10% to 100%. Full instrumentation for constant conditions or program cycles. Sizes from four cubic feet to walk-in rooms.



DRY ICE CHAMBERS



Low cost chamber for product testing, storage, and metal treating. Temperature range −100°F to +200°F.* Automatic control, indicating or recording instrumentation. Easy loading and unloading of dry ice compartment.

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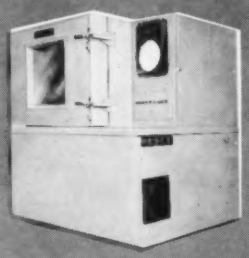
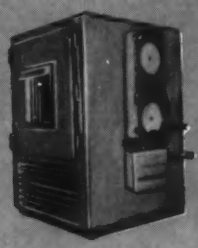
Designed and custom engineered for accurate testing at temperatures of −100°F to +200°F.* with relative humidity 20% to 100%. Recording controlling instrumentation, or program control for MIL specification testing.



TH CHAMBERS



Precision equipment for accurate testing at above freezing temperatures (+35°F to +200°F*) within a humidity range of 20% to 100%. Available with recording controlling instrumentation, or program control for meeting MIL specifications.

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New **low cost** mechanically refrigerated test chamber. 1½ cu. ft. capacity, ideal for laboratories, metal working shops, and testing departments. Temperature ranges of ambient to −40°F, −100°F, −120°F. Table-top or free-standing arrangements. Available as a bath, or as an oven to elevated temperatures.

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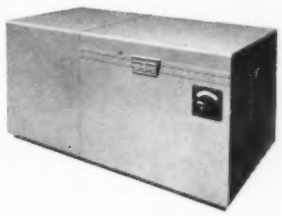

For shrink fitting... hardening and stabilizing dies, gauges, and precision parts... research and production testing of electronic equipment, instruments, plastics, lubricants, etc. Wide variety of sizes, with temperature ranges of ambient to −170°F.

Thousands of Tenney Chambers are now in use. Tenney's highly-specialized engineering and design staff — largest in the industry — will analyze your testing problems and develop the most effective solutions.

Write or wire **today** for complete specifications, performance data and quotations on these units or other environmental test equipment.

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HARRIS REFRIGERATION CO. inc.

6 to 50 cubic foot capacity

accurate temperature control from -100°F to +200°F

Many applications in . . .

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Performance . . .

The Harris chilling chambers are specially designed for environmental testing. The upright cabinets provide convenient accessibility and observation during tests on small components, instruments, and samples. Chamber temperatures can be held continually at any point within the entire -100°F to +200°F range. Thermostatic control is accurate to ±1°F, and constant temperature is maintained throughout the chamber by a specially designed fan. Temperature pull-down time from ambient to -100°F is 50 minutes. When hot environments are required, temperatures of +180°F can be attained in 30 minutes.

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For more information, circle No. 291, Page 13.

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Two Types
"F" Series — Front Opening
"C" Series — Top Opening

Range:
−150° F. to +500° F.

Size:
4 cu. ft. to 72 cu. ft.

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Range:
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Humidity:
10% to 97%
Controlable above a 35° F. D.P.

Size:
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"F" Series — Front Opening

Range:
Temperature:
−150° F. — +500° F.

Altitude:
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Size:
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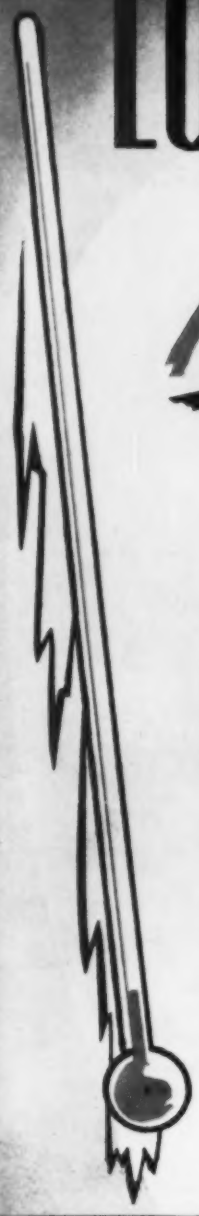

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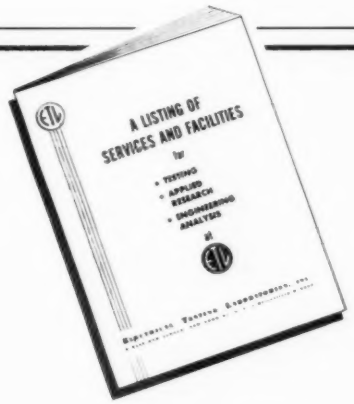
Need Testing Help?



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VIBRATION:	600# force; 2000 cps
ACCELERATION:	50# @ 50 g's
SHOCK:	Per Spec. 7201
TEMPERATURE: & HUMIDITY:	200°F 100% R. H.
TEMPERATURE: & ALTITUDE:	−100°F to +200°F 100,000 ft.
HIGH TEMP.:	To 1,000°F
RAIN:	4" per hour
SUNSHINE:	Per MIL-E-5272A
EXPLOSION:	Per MIL-E-5272A
FUNGUS:	Per MIL-E-5272A
SALT SPRAY:	Per MIL-E-5272A
SAND & DUST	Per MIL-E-5272A

All environmental equipment is suitably instrumented with recording, indicating and controlling devices and fully complies with the requirements of the Military Specification MIL-E-5272A.

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Supplementing the normal services of an environmental test facility, Parameters, Inc. is also capable of functionally testing all components. Parameters, Inc. maintains a complete hydraulic, electronic and mechanical test facility to provide a 'one-stop' testing organization.

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Flows to 100 gpm
Pressure to 5,000 psi dynamic
30,000 psi static
Fluids JP-4, JP-5, Varsol MIL-0-5606, OS45 MIL- -7808

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Power from 1/20 to 160 HP; controlled variable speeds.

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INSTRUMENTATION – General electronic test equipment, including recorders, oscilloscopes, meters and oscillators. Transducers including flowmeters, pressure transducers, thermocouples and potentiometers.

SPECIAL EQUIPMENT – Specialized equipment for testing electrohydraulic closed loop systems includes variable gain servo-amplifier, sine wave generator, phasemeter, servo valve and rotary and rectilinear potentiometers.

FOR MORE INFORMATION ABOUT THE TESTING, ENGINEERING, DESIGN OR DEVELOPMENT FUNCTIONS OF PARAMETERS, INC., WRITE TO:

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For more information, circle No. 331, Page 13.